IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

APPELLANT:	THADDEUS SCHROEDER et al.	)	
		)	Group Art Unit:
SERIAL NUMBER	09/663,030	)	3611
		)	
APPEAL No.	2003-0112	)	Examiner:
		)	D. DePumpo
FILED:	September 15, 2000	)	
		)	
FOR:	PIEZORESISTIVE TORQUE SENSOR	)	

SUPPLEMENTAL APPEAL BRIEF PURSUANT TO 37 CFR 1.193(b)(2)(ii)

1. THE REAL PARTY IN INTEREST

The real party in interest in this appeal is Delphi Technologies, Inc. Ownership by Delphi Technologies, Inc. is established by assignment document recorded for this application on January 27, 2000 on Reel 011423, Frame 0870.

2. RELATED APPEALS AND INTERFERENCES

Appellant knows of no related patent applications or patents under any appeal or interference proceeding.

3. STATUS OF CLAIMS

Claims 1 - 25 are pending in the application. Claims 10 – 25 have been withdrawn from consideration. Claims 1 - 9 stand finally rejected. In particular, Claims 1, 2 and 9 stand rejected under 35 U.S.C. 103(a) as being anticipated by Taig (4,655,092) in view of

Brosh. Furthermore, Claims 3 - 8 stand finally rejected under 35 U.S.C. 103(a) as being unpatentable over Taig in view of Brosh et al and further in view of Buhl, et al.

4. STATUS OF AMENDMENTS

There have been no amendments filed subsequent to receipt of the first final office action.

5. SUMMARY OF INVENTION

The disclosure relates generally to an automotive steering system with a torque sensor. Current methods of measuring the torque applied to an automotive steering shaft are of the compliant kind and are typically accomplished by use of a torsion bar as part of the shaft, joining an upper and lower section thereof. The torsion bar is made of material with known mechanical properties and hence has known compliance. Thus, the applied torque can be calculated from a measured angular displacement, $\Delta\theta$, of the torsion bar (usually in the range of plus or minus a few degrees). The calculated torque is applied to a controller, which then directs an electric steering torque assist motor to provide assist torque to the steering shaft.

However, this method introduces additional compliance into the control system - an undesirable parameter affecting the speed of response and the feel of the steering action. This method also suffers from the added expense of additional parts and the fabrication thereof.

The problems of the prior art are overcome by providing a simplified torque sensor for direct sensing of the torque applied to a shaft to which the sensor is connected. In particular it is desirable to provide a faster and more accurate non-compliant measure of the torque applied to the shaft by the driver.

This invention comprises an automotive steering system 100 comprising a shaft 102 which is linked to a set of road wheels 118. (*Fig. 1; p. 6, l8 – 12*). The shaft 102 includes a slot 103 parallel to the axis of the shaft 102 and located at a single peripheral location about the surface of the shaft (*Figs. 11, 14A – 14D; p. 8, l. 16 - 25*). A piezoresistive sensor 120 is positioned within and along the length of the slot 103 and is responsive as a

cantilever beam to torque applied to the shaft 102. (*Fig. 4; p. 7, l. 12 - 21*). The piezoresistive sensor 120 is operative to provide as output a signal 120a indicative of the applied torque. A controller 110 is in signal communication with the sensor 103 and is operative to accept as input from the sensor 103 the signal 120a indicative of the torque applied to the shaft 102 (*Fig. 1; p. 6, l. 14 - 19*). A motor 112 is coupled to the shaft 102 and is in signal communication with the controller 110. The motor 112 is operative to accept as input from the controller 110 a command 110a to apply torque to the shaft 102. (*Fig. 1; p. 6, l. 14 - 19*).

6. <u>ISSUES</u>

There are two issues on appeal:

i. whether the Examiner's rejection of Claims 1, 2 and 9 under 35 U.S.C. § 103(a) as being anticipated by Taig in view of Brosh et al. is improper; and

ii. whether the Examiner's rejection of Claims 3 - 8 under 35 U.S.C. § 103(a) as being unpatentable over Taig in view of Brosh et al. and further in view of Buhl et al. is improper

7. <u>GROUPING OF CLAIMS</u>

There are two groups of claims. Claims 1, 2 and 9 comprise the first group, which stand or fall together, under the Examiner's contested rejection of these claims under 35 U.S.C. §103(a) as being unpatentable over Taig in view of Brosh et al.. Claims 3 - 8 comprise the second group of claims, which stand or fall together, under the Examiner's contested rejection of these claims under 35 U.S.C. §103(a) as being unpatentable over Taig in view of Brosh et al. and further in view of Buhl et al.

8. <u>ARGUMENT</u>

A. The Examiner improperly rejected Claims 1, 2 and 9 under 35 U.S.C. §103(a).

For an obviousness rejection to be proper, the Examiner must meet the burden of establishing a *prima facie* case of obviousness. In re Fine, U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988). The Examiner must meet the burden of establishing that *all* elements of the invention are disclosed in the prior art; that the prior art relied upon, coupled with knowledge generally available in the art at the time of the invention, must contain some suggestion or incentive that would have motivated the skilled artisan to modify a reference or combine references; and that the proposed modification of the prior art must have had a reasonable expectation of success, determined from the vantage point of the skilled artisan at the time the invention was made. In re Fine, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988); In re Wilson, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970); Amgen v. Chugai Pharmaceuticals Co., 927 U.S.P.Q.2d, 1016, 1023 (Fed. Cir. 1996). Moreover, the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

The Appellants respectfully submit that there is no combination of Taig and Brosh that teaches, nor even suggests Appellants' claimed invention. In fact, Taig and Brosh do not teach "all of the elements" of Appellants' claimed invention. As presented in the Appellants Appeal Brief of May 30, 2002, and Reply Brief of September 30, 2002, the Appellants respectfully submit that the disclosure of Taig and the invention encompassed by the present Claims 1, 2 and 9 of this application are fundamentally different in structure and thus in their resultant mechanical effects. Appellants rely upon the statements therein to support this reinstatement of the appeal. Further discussion is also provided to address the Examiner modified rejection and facilitate the Board's review.

Under the first grouping of claims, the issue is whether the Examiner improperly rejected independent Claim 1.

In response to the first Office Action, Claim 1 was amended to include the recitation of a piezoresistive sensor *responsive as a cantilever beam*. With regard to the issue of the cantilever beam, the Examiner states, in the Final Office Action of November 5, 2001, that:

> "This function is taught by Taig. Clearly, one end of the beam will move with respect to the other end when the shaft is subject to torsional forces."

The Appellants believe that this is incorrect and that Taig does *not* teach a cantilever beam, nor a sensor that could possibly be *responsive* as a cantilever beam as required in Claim 1. The sensor in Taig is shown in Figure 2. Torsional member 20 fits into the opposing slots 100 and thus straddles axis 82 and input member 16. A tab portion 77 of torsional member 20 engages slot 64 in output member 18. In Figure 2 the Board's attention is directed to torsion member 20, which "is elongated, and flat with a central portion 66 of reduced lateral dimension." (*Col. 3, lines 45 – 47*). This central portion, having a reduced lateral dimension, defines an area parallel to the axis 82 and located between the tabs designated by the reference numerals 70 and 74. This area might best be referred to as a "void area" because there is in fact nothing there. This fact is important and will be addressed in a moment. Furthermore, "A strain sensitive element such as a strain gauge 94 is fixedly secured to one of the surfaces of the torsion member in conventional manner." (*Col. 4, lines 7 – 9*). Also as seen in Figure 2, the strain gauge 94, which is the sensing element in Taig, is situated over the *central portion* 66 of the torsion member 20 and thus also *straddles* axis 82. This fact bears directly upon the nature of the response of the strain gauge 94 to an applied torque.

The nature of the sensor in Taig is such that, upon the application of a torque to the steering column, i.e., to the cylindrical input member 16, there will be a slight rotation of input member 16 with respect to output member 18 about the axis 82. As a consequence, torsional member 20, which is positioned within slot 100 and symmetric about axis 82, will twist about axis 82. In order to gain a better visualization of the twisting suffered by torsional member 20 reference is made to Figure 6-3(d) of *Mechanics of Materials* by W. Riley, L. Sturges and D. Morris; John Wiley & Sons, 1999 (a copy of pages 272 – 275 thereof is attached hereto as Appendix B for the Board's ready reference). The twisting of torsional member 20 is as shown in Figure 6-3(d) of *Mechanics of Materials.*

Returning now to the so called "void area," upon assembly of the arrangement shown in Figure 2 of Taig, this "void area" is located coincident with the periphery of the

shaft that makes up the input member 16. However, this "void area" is *just* that area, or location, in which the sensor of the present application is in fact found. This is clearly seen in Figures 14A – 14D of the application as filed. Thus, even if tabs 70 and 74 of Taig are displaced with respect to one another in response to an applied torque, as the Examiner seems to be saying in the above quote, there is no material between these tabs. In other words, there is simply nothing in this "void area" to *act* as a sensor. Thus, Taig is missing an element of Claim 1, namely *a piezoresistive sensor positioned within and along the length of a slot which is parallel to the axis of a shaft and located at a single peripheral location about the surface of the shaft.* (Appellants further direct the Board's attention to Appellants' Reply Brief, second paragraph.)

In order to more fully grasp the distinction between the nature of the sensor in Taig and that of the present application, it will be instructive to also examine the stresses that are set up in the torsional plate 20 of Taig vs. the stresses found in the sensor 120 of the present application. The stresses set up in the torsional plate 20 of Taig as a result of the torsional loading, are at an angle with respect to the axis 82. This follows from the twisting shown in Figure 6-3(d) of *Mechanics of Materials*. In stark contrast, the stresses that result from the loading applied to the sensor of the present application are parallel to the axis of the beam, e.g. they are compressive on one side of the beam and tensile on the opposite side. In the cantilever beam of the present application, one end of the beam moves with respect to the other as it is subject to a load as shown in Figure 4 of the application. The applied load is perpendicular to the length of the beam. There is absolutely *no* torsional loading of the sensor. The only loading of the sensor in the present application is as a cantilever beam. A cantilever beam "is a member with one end projecting beyond the point of support, free to move in a vertical plane under the influence of vertical loads placed between the free end and the support." *Handbook of Engineering Fundamentals, O. W. Eshbach and M. Souders , Ed., John Wiley & Sons, 3rd Ed. 1975.* (Appendix C.).

As noted above, the strain gauge 94 in Taig, is, in fact, situated over the *central portion* 66 of the torsion member 20 and thus also *straddles* axis 82. The torsion member 20 *twists* about axis 82, i.e. it is a member under *torsion*. Because of the fact that the strain

sensor 94 is located along the axis 82, and due to the nature of the stresses set up in the torsional plate 20, the strain sensor 94 would need to be set off *at an angle* with respect to the axis 82 (i.e. *not parallel to the axis*); much as the conventional manner in the strain sensor shown in the U. S. patent to H. Brier (2,754,465). However, these sensors, and thus the sensor 94 of Taig, do *not* respond as cantilever beams. Once again, the Board is invited to also review the Appellants Reply Brief for additional discussion regarding the abovementioned distinctions.

Thus, it must be seen that the sensor 94 in Taig is neither *responding as a cantilever beam* as required by Claim 1, nor is it *positioned within and along the length of a slot* which is *parallel to the axis of a shaft* and located at a single peripheral location about the surface of the shaft, also as required by Claim 1.

Thus, based upon the foregoing remarks, the Appellants respectfully submit that Claim 1 as amended in the response to the first Office Action, clearly distinguishes over Taig and therefore stands in condition for allowance. Claims 2 and 9, which depend directly from Claim 1 are therefore also allowable for at least the same reasons as set forth with regard to Claim 1.

B. Claims 3 - 8 are patentable under 35 U.S.C. §103(a).

The Appellants respectfully submit that there is no combination of Taig, Brosh and Buhl that teaches, nor even suggests, a piezoresistive sensor *responsive as a cantilever beam*; nor is there any combination of Taig, Brosh and Buhl that teaches, nor even suggests a piezoresistive sensor *positioned within and along the length of a slot which is parallel to the axis of a shaft and located at a single peripheral location about the surface of the shaft*, both of which are required by Claims 1 and 3.

In fact, as also presented for Taig above, Taig teaches *away* from the invention encompassed by Claim 1 by virtue of the torsion member 20 being "elongated, and flat with a central portion 66 of reduced lateral dimension", i.e., the so called "void area." (*Col. 3, lines 45 – 47*). The present application in fact fills the technological vacuum of the "void area" explicitly *created* by, and certainly not addressed by, Taig; nor for that matter

Brosh or Buhl.

Thus, the Examiner has not met the burden of establishing that *all* elements of the invention are disclosed in the prior art and has therefore not met the burden of establishing a *prima facie* case of obviousness with respect to Claim 3, which depends from Claim 1. Claims 4 - 8 which depend variously from Claim 3 are therefore also allowable for at least the same reasons as set forth with regard to Claim 3.

C. Conclusion

For the reasons cited above, Appellants respectfully submit that the rejections are improper and request reversal of the outstanding rejections. If there are any additional charges with respect to this reinstatement of Appeal or otherwise, or otherwise, please charge them to Deposit Account No. 06-1130.

Respectfully submitted,
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9. APPENDIX A

Appealed Claims

1. An automotive steering system comprising:

a shaft linked to a set of road wheels, the shaft including a slot parallel to the axis of the shaft and located at a single peripheral location about the surface of the shaft;

a piezoresistive sensor positioned within and along the length of the slot and responsive as a cantilever beam to torque applied to the shaft and operative thereby to provide as output a signal indicative of the applied torque;

a controller in signal communication with the sensor and operative thereby to accept as input from the sensor the signal indicative of the torque applied to the shaft; and

a motor coupled to the shaft and in signal communication with the controller and operative thereby to accept as input from the controller a command to apply torque to the shaft.

2. The automotive steering system as set forth in Claim 1 wherein the shaft includes

a first section;

a second section linked to the set of road wheels; and

a third section joining the first and second sections.

3. The automotive steering system as set forth in Claim 1 wherein the piezoresistive sensor comprises at least one piezosensitive element coupled to a ceramic substrate.

4. The automotive steering system as set forth in Claim 3 wherein the at least one piezosensitive element is part of an electric circuit.

5. The automotive steering system as set forth in Claim 3 wherein the at least one piezosensitive element is connected to an amplifier operative thereby to provide as output the signal indicative of the torque applied to the shaft.

6. The automotive steering system as set forth in Claim 4 wherein the at least one piezosensitive element includes a piezoresistor.

7. The automotive steering system as set forth in Claim 4 wherein the electric circuit comprises a bridge circuit.

8. The automotive steering system as set forth in Claim 7 wherein the bridge circuit is a wheatstone bridge.

9. The automotive steering system as set forth in Claim 1 wherein the shaft includes

a hub connected to the shaft; and

a steering wheel connected to the hub.